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ABSTRACT

This study focused on anxiety, both math and situational, and its relationship to teaching performance. Preservice elementary teachers were given a methods course on teaching mathematics and, after five weeks, were assigned a group of children to instruct twice a week. A positive correlation was found between performance in teaching math and attitudes toward mathematics. No significant correlation was found between general math anxiety and teaching performance. It is suggested that the primary level of mathematics generates little anxiety for most preservice teachers. The findings did not strongly support a relationship between attitudes about math and the experiencing of a math methods course, but did support the lowering of mathematics and situational anxiety levels as a result of experiencing such a course. (JD)

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EFFECTS OF A MATHEMATICS METHODS COURSE ON PROSPECTIVE ELEMENTARY SCHOOL TEACHERS' MATH ATTITUDES, MATH ANXIETY AND TEACHING PERFORMANCE

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Considering the influence elementary school teachers have on their students, it is not surprising to learn that mathematics educators are concerned about the attitudes elementary school teachers have toward mathematics and the anxiety that could affect successful teaching of children. Phillips (1973) reported evidence that the teacher's attitude toward mathematics is significantly related to the student's attitude and achievement in mathematics. Compounding this problem is the finding that as one goes down the grade levels from secondary to early elementary, attitudes toward mathematics worsen (Early, 1970). Reacting to this problem, educators have attempted through methods courses to influence prospective elementary teachers' attitudes toward mathematics. The result of these methods courses has been to have, in general, a positive effect on the attitudes of prospective elementary school teachers, relative to those not enrolled in such a course (Collier, 1970; Taylor, 1970).

While we know that attitudes toward mathematics can be improved through methods courses, we know little about how attitudes affect the teacher's behavior (Aiken, 1976). How is teaching performance affected by attitudes toward mathematics, as well as math anxiety, and situational anxiety? Can a mathematics methods course reduce both math anxiety and situational anxiety?

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The present study sought to answer the following questions:

1. Does a mathematics methods course improve prospective elementary school teachers' teaching performance?
2. Does a mathematics methods course improve prospective elementary school teachers' attitudes toward mathematics?
3. Does a mathematics methods course improve prospective elementary school teachers' math anxiety?
4. Does a mathematics methods course improve prospective elementary school teachers' anxiety during a teaching episode?
5. How do attitudes towards mathematics relate to prospective elementary school teachers' teaching performance?
6. How does math anxiety relate to prospective elementary school teachers' teaching performance?
7. How does situational anxiety relate to prospective elementary school teachers' teaching performance?

METHOD

SUBJECTS:

The subjects for the study consisted of 66 female sophomore and junior college students enrolled in either a mathematics methods course or a children's literature course. The 35 subjects in the mathematics methods course were randomly assigned to either the experimental group (E) or control group (C2). The 31 subjects in the children's literature were assigned to the remaining control group (C1).

Instrumentation

Performance was assessed with a five point observational scale constructed for this study to encompass the five criteria of preparation, motivation, interaction with children, instruction and evaluation. The ratings were assigned during the teaching episodes.

The Mathematics and Me scale (Anttonen, 1967) was used to assess attitudes toward mathematics. This semantic differential scale with the set of items balanced for acquiescence set asks the respondents to establish along a 7 point scale their feelings about mathematics as associated with the 16 pairs of opposite adjectives.

The mathematics anxiety scale developed by Brush and Baruch is a 40 item instrument with items split distributed equally between those assessing feelings about doing mathematics related behaviors and literature/writing activities. The subject is asked to rate on a scale of 1 to 5 the level of anxiousness and uncomfortableness felt about the described situation.

Situational anxiety was measured with the state part of the State-Trait Anxiety Inventory (STAI). The State scale is balanced for acquiescence set with half of its 20 items reversed for scoring weight. A higher score indicates more situational anxiety.

Treatment

The treatment was considered to be the combined effect of the mathematics methods course for pre-service elementary teachers and the teaching episodes with children built within the course. The lecture/discussion aspect consisted of two 2-hour classes a week for the first five weeks and two 1-hour classes for the remainder of the 14 week course.

The lecture/discussion part of the course took the students through a standard sequence of developmental mathematical concepts (e.g., sets, number, operations on whole numbers, fractions and decimal fractions, geometry, measurement), reviewing understandings of these concepts and discussing applications to work with children. The course reviewed Piagetian developmental stages with particular emphasis on conversation tasks. Films depicting use of concrete materials and mathematics in British open school contexts were viewed, and laboratory exercises using a variety of materials were conducted in class. Also was included development of lesson plans and the application of Bloom's Taxonomy to the development of higher level questions. The students taught one lesson incorporating pre- and post-tests with questions on several levels of the taxonomy to their peers before beginning their teaching with children.

At the five week point students were assigned a group of children in Stephens College elementary program for whom they prepared instruction twice a week. Each student pre-tested the children for instant recall of number facts, provided a "drill" program as part of each contact, and post-tested them at the end of the 14 week term. The major part of the teaching episodes consisted of teaching from a prepared lesson approved by the children's teacher prior to the contact. The student was required to plan lessons with well-defined objectives and to include motivating activities utilizing games

and concrete materials. After teaching a lesson, the student evaluated her lesson and received feedback from the head teacher with an opportunity to ask questions about perceived difficulties and/or anticipated planning needs. In addition the student was given a numerical rating from 1 to 5 on "achievement" broken down into sub-ratings of preparation, motivation, interaction with children, ability to instruct, and evaluation.

Although the treatment was the global experience consisting of the two dimensions of content and class experiences on the one hand and teaching of children on the other, the experience of a class per se was to an extent controlled by group C1 in the Literature for Children course. In addition the probes with X-1 provided a basis for focusing on situational anxiety while the students were working with children, thus providing a topography traced by their interactions with children.

Procedure

The experimental treatment for the study was a mathematics methods course conducted for prospective elementary school teachers. A Solomon Three-Group Design was used to assess changes in attitudes toward mathematics. This design has the advantage of allowing the researcher to check for pretest-treatment interaction. Changes in math anxiety and teaching performance were assessed at several points during the course.

After the students were assigned to their groups, Group E (experimental group) and Group C1 (control group 1) were administered the Brush-Baruch scale, Mathematics and Me, and the STAI as pretests. Prior to each teaching episode the students in Group E were given additional administrations of the STAI-State instrument. Teaching performance was assessed during the students' presentations. Each student made twelve presentations during the course. At the conclusion of the course all of the students in Groups E, C1 and C2 (control group 2) were administered all of the instruments as posttests.

RESULTS

Means and standard deviations for subjects' pre-test and post-test scores on mathematics attitudes, math anxiety, state anxiety, and teaching performance are reported in Table 1.

Differences in teaching performance scores for subjects in the mathematics methods course were examined using a t-test analysis of subjects' pre-test and post-test scores. The results, presented in Table 2, indicated that subjects' teaching performance improved significantly over the period of the course ($t=2.44$, $df=21$, $p < .05$).

An analysis of variance on the math attitude post-test scores was performed using Fisher's LSD. No pre-test-treatment interaction was found. The results of an analysis of covariance, with mathematics attitudes pre-test scores as the covariate, on subjects' mathematics attitudes post-test scores, reported in Table 3, indicated that at the end of the semester subjects in the mathematics methods course reported non-significant changes in attitudes toward mathematics ($F=2.609$, $df=1.50$, $p > .1$).

In Table 4 are reported the results of an analysis of covariance, with math anxiety pre-test scores as the covariate, on subjects math anxiety post-test scores. The analysis indicated that subjects in the mathematics methods course experienced a significant reduction in their anxiety about mathematics ($F=6.64$, $df=1.50$, $p < .05$).

State anxiety during a teaching episode was significantly reduced for subjects in the mathematics methods course ($F=21.2$, $df=1.50$, $p < .001$). The results of the analysis of covariance are reported in Table 5. State anxiety pre-test scores were used as the covariate.

Subjects' teaching performance and attitudes toward mathematics were found to be significantly and positively correlated ($r=0.4532$, $p < .01$). As subjects attitudes toward mathematics improved so did their performance in teaching a mathematics lesson.

Subjects' teaching performance was found to be negatively, but non-significantly correlated with math anxiety ($r=-0.2617$, $p > .05$). It appeared that while subjects were anxious about mathematics, it did not affect their teaching performance.

A negative, significant correlation was found between subjects' teaching performance and their state anxiety during a teaching episode ($r=-0.5901$, $p < .01$).

DISCUSSION

As we look at the various forces playing upon or generated by a mathematics methods course for teachers the complexity becomes increasingly evident. The most straightforward finding in this study was perhaps the most predictable, that is, that as a result of monitored teaching episodes with children, pre-service teachers would significantly improve on performance criteria. This would be expected since the criteria were specified and feedback and assistance were given the teachers as they moved through twice a week instructional time they planned and implemented. It would have been surprising to find the absence of positive change. Achievement measures of children were not examined nor was there access to a control group of pre-service teachers instructing children in math outside the structure of a math methods course. We can point to time-on-task studies as a reasonable basis for accepting the former; the latter is a difficult condition to effect in a human situation.

The primary focus of the study centered around anxiety, both math and situational, and its relationship to teaching performance within the structure of a math methods course. Anxiety about mathematics in general as measured in this study was lowered significantly compared to the control group as were the measures of anxiety taken just before teaching episodes. This was a pre-post measure. For the experimental subjects six probes were taken along the way which should yield upon further analysis a topography of possible interest in describing anxiety relationships. Regardless of possible fluctuations, however, the effect over time was positive in lowering measures of the anxiety constructs.

The correlates of teaching performance and attitude/anxiety measures were more complex. These comparisons were made between subjects in the math methods course only. Not surprisingly there was a positive correlation between performance in teaching math and attitudes toward mathematics. It would be expected that those teachers feeling comfortable with math, perhaps as a result of their own perceived conceptual or operational strength, would be able to move ahead more readily to strengthen other performance criteria areas.

The correlation was not significant between general math anxiety and teaching performance. This relationship, or rather the lack of a systematic relationship may be a function of the measure used. The anxiety measured by response to items perceived to be about the pre-service teachers' recent history with math subjects such as high school or college alegebra simply may not get in the way of teaching beginning concepts to young children. Most of the children were of primary age and the level of mathematics, particularly those concepts that precede operations with fractions, may generate little anxiety for most of the pre-service teachers.

The situational anxiety was significantly related to teaching performance in a negative direction. This would not necessarily contradict the above finding because it was a direct time sequenced measure between anxiety and teaching performance, the probe being taken just before teaching. Several questions are generated, however. One can note the expected relationship between situational anxiety and performance, but it is not evident that it was a function of an anxiety about mathematics. Further isolation of this variable would be necessary.

In summary the findings did not strongly support a relationship between attitudes about math and the global experience of a math methods course ($p > .11$) but did support the lowering of mathematics and situational anxiety levels as a result of experiencing such a course by pre-service teachers. Within the experimental group, the absence of a significant relationship between math anxiety and teaching performance bears more investigation, particularly with respect to anxiety responses across a hierarchy of perceived mathematical difficulty levels. Further, a closer look at the structure of situational anxiety with designs capable of isolating variables within this structure could prove useful in identifying those characteristics of a math methods course worth developing emphasis.

Finally, it can be observed that the results of this study point to several positive indicators for the value of a mathematics methods course for prospective teachers. In one sense a broader question than the research questions posed in this study is given paranthetical support; that is, do courses in specific subject methodology enhance the preparation of pre-service teachers? Does performance in teaching with its related correlates and/or causal variables actually change as a result of the experiences provided in a math methods course? Perhaps this more basic question which is not necessarily taken for granted by those not involved in preparing teachers is given some support, thus providing an added impetus for further investigation of the variables mentioned above.

Table 1

Means and Standard Deviations on Mathematics Attitudes, Math Anxiety, State Anxiety, and Teaching Performance for Subjects in the Mathematics Methods Course (E) and the Control Groups (C1, C2)

Group	N	Math Attitudes		Math Anxiety		State Anxiety		Teaching Performance	
		$\bar{x}$	SD	$\bar{x}$	SD	$\bar{x}$	SD	$\bar{x}$	SD
E	22	52.5	11.5	33.4	26.9	42.2	11.2	2.53	1.48
	(22)	(52.9)	(15.3)	(27.7)	(21.1)	(29.5)	(8.1)	(4.24)	(0.85)
C1	31	57.3	12.3	50.0	15.3	43.3	10.7	-	-
	(31)	(53.2)	(14.2)	(47.6)	(15.5)	(43.2)	(13.5)	-	-
C2	13	-	-	12.3	21.1	44.5	17.3	1.05	1.65
	(13)	(56.2)	(10.1)	(10.9)	(17.7)	(30.5)	(11.3)	(4.28)	(0.83)

*Post-Test Scores Are in Parentheses

Table 2

t-test Analysis of Pre-Test and Post-Test Scores on Teaching Performance for Subjects in the Mathematics Methods Course (E)

	Teaching Performance						
	Pre-Test			Post-Test			
Group	N	$\bar{x}$	SD	N	$\bar{x}$	SD	t
E_1	22	2.53	1.48	22	4.24	0.85	2.44*

*$p < .05$

Table 3

Analysis of Covariance of Mathematics Attitudes Post-Test Scores for Subjects in the Mathematics Methods Course and Control Group C1

Source of Variation	Sum of Squares	df	Mean Square	F
Covariate				
Mathematics Attitudes Pre-Test	6483.2	1	6483.2	
Main Effects				
Groups	225.2	1	225.2	2.609*
Explained	6708.4	2	3354.2	
Residual	4317.2	50	86.3	
Total	11025.6	52	212.0	

*p > .1

Table 4

Analysis of Covariance of Math Anxiety Post-Test Scores for Subjects in the Mathematics Methods Course and Control Group C1

Source of Variation	Sum of Squares	df	Mean Square	F
Covariate				
Math Anxiety Pre-Test	15024.1	1	15024.1	
Main Effects				
Groups	774.8	1	774.8	6.64*
Explained	15798.8	2	7899.4	
Residual	5837.5	50	116.7	
Total	21636.4	52	416.1	

*$p < .05$

Table 5

Analysis of Covariance of State Anxiety Post-Test Scores for Subjects in the Mathematics Methods Course and Control Group C1

Source of Variation	Sum of Squares	df	Mean Square	F
Covariate				
State Anxiety Pre-Test	1752.7	1	1752.7	
Main Effects				
Groups	2234.8	1	2234.8	21.2*
Explained	3987.5	2	1993.7	
Residual	5273.7	50	105.5	
Total	9261.2	52	178.1	

* $p < .001$

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